ARPA **Advanced Research Projects Agency**

REPORT OF THE SENIOR WORKING GROUP ON MILITARY OPERATIONS OTHER THAN WAR (OOTW)

May 1994

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REPORT OF THE SENIOR WORKING GROUP

ON

MILITARY OPERATIONS OTHER THAN WAR (OOTW)

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ABSTRACT

This report, commissioned by ARPA, contains the results of a study conducted to investigate the means to enhance the effectiveness and survivability of U.S. forces engaged in Military Operations Other Than War through the application of advanced technologies. ARPA convened a Senior Working Group (SWG) to assist in developing a vision and implementation plan for this initiative. This report presents the culmination of these efforts, including a vision statement for the ARPA initiative, rationale supporting this initiative, and program recommendations.

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> **"Today, as an older order passes, the new world is more free but less stable. Communism's collapse has called forth old animosities and new dangers."**
>
> ***President Bill Clinton, January 20,1993, Inaugural Address***

Introduction

The world is no longer bipolar. Consequently, the post-Cold War strategic environment is ill-defined, dynamic, and unstable. The nature of this environment and the military threats it fosters indicate that U.S. forces (1) will face a widely diverse range of adversaries equipped with an ever increasing array of sophisticated weapons, and (2) will require a span of operational response capabilities that ranges from military operations other than war (OOTW)—such as deterring or engaging small, unsophisticated, fanatical terrorist groups—to conducting significant military operations against regional powers, which may well possess advanced weapons systems, including nuclear, biological and/or chemical weapons of mass destruction (WMD). The United States must be prepared for the challenges of this range of military threats. It must maintain enough capable, versatile, trained, and ready military forces able to meet this spectrum of security challenges that is unprecedented in ambiguity, diversity, and risk.

Objectives and Approach

Because of the increasing trend of U.S. military involvement in OOTW—particularly the events in Somalia during the summer and fall of 1993—the Advanced Research Projects Agency (ARPA) identified a need to enhance the effectiveness and survivability of U.S. forces engaged in these operations through the application of advanced technologies. ARPA convened a Senior Working Group (SWG) to assist in developing a vision and implementation plan for this initiative. Although the SWG focused on long-term development requirements, key near- and mid-term enabling technologies for application to immediate problems were also of interest.

To achieve this objective, the SWG surveyed (1) technology developments for potential application to OOTW, OOTW doctrine and operations, and the current and projected strategic environment; then (2) collectively synthesized this information through the experience and knowledge of its members. The SWG's members brought to this effort extensive experience in special operations, low- and mid-intensity conflict, and a broad range of skill's applicable to OOTW, including expertise in intelligence, law enforcement, and security.

This report presents the culmination of these efforts including: a vision statement for the ARPA initiative; rationale supporting this initiative; and program recommendations.

Vision

> **"Military operations other than war encompass a wide range of activities where the military instrument of national power is used for purposes other than the large-scale combat operations usually associated with war. Although these operations are often conducted outside the United States, they also include military support to U.S. civil authorities. Military operations other than war usually involve a combination of air, land, sea, space and special operations forces as well as the efforts of governmental agencies and non-governmental organizations in a complementary fashion."**
>
> ***JCS Pub 3-0 (9 September 1993)***

OOTW vary from simple disaster relief at the lower end of the spectrum of potential operations to major military intervention short of declared war or major conflict at the upper end (See Figure ES-1). These operations are not necessarily limited in size and complexity, nor cost in property, money, or lives. Moreover, these operations may gradually or suddenly escalate to a crisis of greater proportions than originally expected. The nature of OOTW is largely determined by the circumstances that lead to its initiation, the character of the opposing forces, a particular operation's objective(s) importance to U.S. interests, and the intended outcome of the operation.

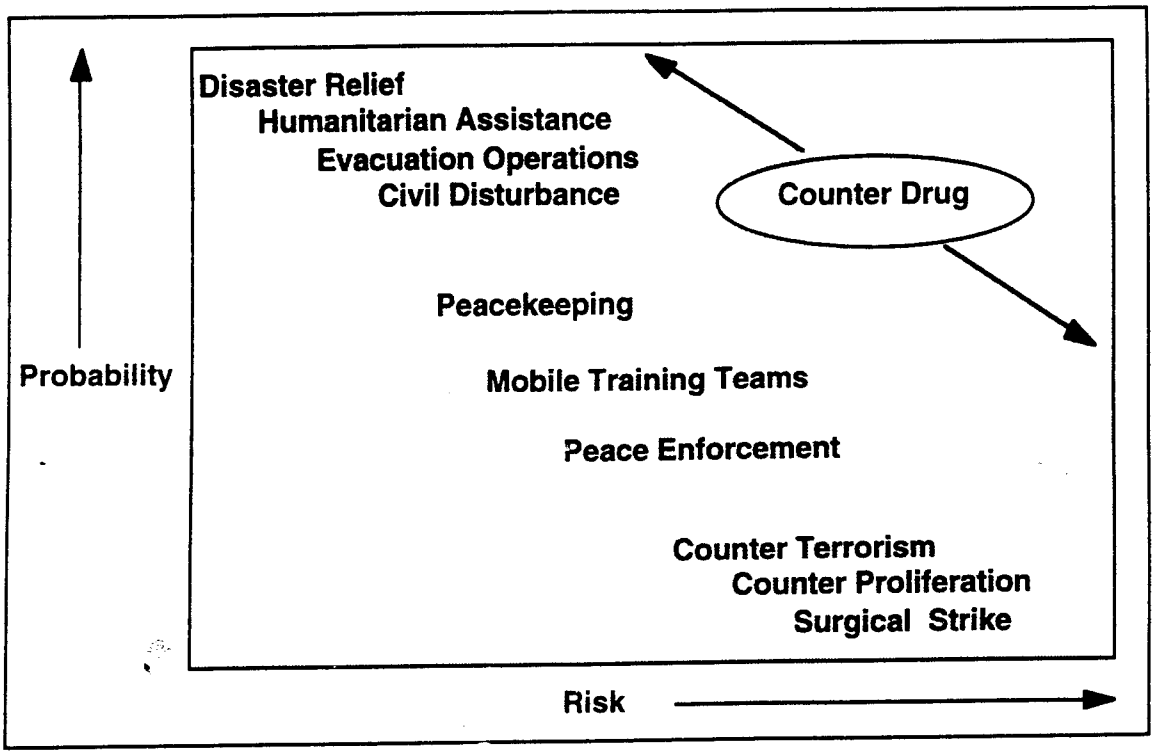

Figure ES-1. Spectrum of Operations Other Than War

The SWG viewed OOTW being the predominant form of future U.S. military operations at least well into the next century. Despite the normally relatively modest scale of OOTW operations as compared to other types of military operations, OOTW will be predominant in frequency, political impact, and long-term importance. Individually, these operations will initially reflect their political environment, then change and define it. In order for the nation to succeed in OOTW, it is imperative that the Armed Forces be adequately equipped, well supported, and well trained both as individuals and as units. The SWG envisioned ARPA's initiative as a means of providing the military commander, through the application of advanced technology, those capabilities necessary for the more effective employment of military force in OOTW; particularly with respect to accommodating the politically based mandates to keep casualties, both U.S. and others, to an absolute minimum.

Developing and fielding the technologies advocated in this study are offered as one of the few available options for providing value-added capability to U.S. Armed Forces

that will be engaged in OOTW. The path that such developmental efforts should follow is:

- Identifying OOTW-unique requirements in close coordination with the user
- Identifying those requirements not adequately met by conventional military capabilities, and determining which of those requirements can be addressed by technology
- Finally, determining those requirements for which there are no existent, or developmental, technology solutions.

What Makes OOTW Different?

Although exceptions can be cited, the following characteristics are common to most non-domestic types of OOTW:

- Limited objectives and a sometimes less than explicit tie to national interests lead to intense political pressures to minimize casualties and collateral damage
- The media has a significant impact on public perceptions of success/non-success
- Military capabilities may be limited by restrictive rules of engagement
- The United States is not always in charge—U.S. forces may be operating as part of a UN force or of a coalition
- Operational intelligence is a paramount requirement for success
- Urban operations are common, frequently involving large crowds of civilians and language barriers
- Unique training challenges exist when preparing forces for decentralized, small- unit operations
- Specific goals and/or objectives, to include desired end-state, are not always well defined
- Operations are complicated by the potential for rapid escalation
- Psychological operations and civil affairs acquire added emphasis

- Time limits on involvement are restrictive.

Key Problem Areas and Shortfalls

The first priority for our military is to maintain adequately prepared forces to successfully meet the requirements associated with major regional contingencies. However, the likelihood of involvement of U.S. forces in OOTW greatly exceeds that of their involvement in major regional contingencies. Considering the unique requirements associated with OOTW, the following are shortfalls in the current capabilities for which solutions should be found:

- Inadequate nuclear, biological and chemical detection capabilities in non-permissive environments
- Inadequate capabilities to detect, locate and neutralize bunkers, tunnels, and underground facilities
- Limited secure, real-time command and control to lower echelon units
- Limited operational intelligence collection and dissemination capabilities
- Inadequate mine, booby trap, and explosives detection capabilities
- Inadequate non-lethal capabilities for neutralizing equipment and personnel (Mission Kill)
- Limited non-intrusive drug detection capabilities
- Inadequate modeling/simulations for training, rehearsal, and operations
- No real-time voice recognition language translation capability
- Inadequate ability to deal with discrete hostile sniper and mortar attacks.

Many of these problem areas and shortfalls are obviously applicable to other types of military operations.

Required Technologies

Table ES-1 identifies technology requirements having key applicability and exceptional importance to OOTW. The breadth of the technologies identified reflect the great diversity of OOTW, ranging from capabilities to protect individuals, to those that

CATEGORY	FORCE PROTECTION	FORCE ENHANCEMENTS	COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS, AND INTELLIGENCE (C4I)	FORCE PROJECTION & SUSTAINMENT
Priority I	• Invisible Soldier - Image avoidance - Signature reduction • Mine, Booby Trap and Explosives Detection and Neutralization	• Tactical Detection of Weapons of Mass Destruction (WMD) • Advanced Night Vision (NV) Equipment • Non-lethal Weapons Systems • Mission Kill - Area and Point	• Low-Signature Unmanned Aerial Vehicles (UAV) • Common Language Voice Recognition Translator	• Reduced Visibility Penetrator Aircraft
Priority II	• Anti-Mortar (Light Indirect Fire) Capability • Extremities Protection • Anti-sniper System	• Detection and Destruction of Underground Facilities • Non-intrusive Drug Detection	• Room Monitor • Chemical/Biological Expert System • Virtual Reality Modeling and Simulations for Training, Planning and Rehearsals	• Survival Tag and Tracking System • Combat Search and Rescue (CSAR) Command and Control (C^2) System
Priority III	• Biological-Medical Treatment Capability	• Stand-off Precision Breaching Weapons (Squad/Team) • Stand-off Neutralization of Weapons of Mass Destruction	• See-through Capability for Buildings and Structures • Strategic/ Discriminating Remote Sensors	• Universal Long-Life/ Light-Weight Power Source • Strategic Airlift Capability • Floating Sea Base Capability

Table ES-1. Required Technologies

protect entire cities. To focus this effort, the selected requirements were prioritized. Priority I requirements, however long the development cycle is, should be addressed now. Priority II and III requirements should be developed as soon as technology and resources permit. A full description and justification for each of these technologies are discussed in Chapter III.

Summary

The ARPA OOTW technology initiative is imaginative, potentially very productive, and, given current world conditions, timely. In view of the geopolitical situation and the reality of decreased resources, the best option for improving our OOTW capabilities is through development and application of revolutionary technologies. *ARPA should*

identify and invest in developing breakthrough technologies that synergistically provide U.S. Armed Forces and government and civil agencies distinct advantages in accomplishing OOTW missions. Further, these technologies have potential application in other areas of national importance.

Because of the similarity of threats and the constraints placed on the application of force in OOTW, the challenges faced by military forces in OOTW and law enforcement agencies have converged. Consequently, technologies developed to enable military forces to better meet the challenges of the OOTW environment may also have applicability to law enforcement needs.

While this report focuses on technology, it must be noted that not all changes in the OOTW environment are related to technology. The changing political world and the tumultuous conditions discussed in Chapter II are having operational and doctrinal impacts that have little relationship to technology. One of the results of these conditions is that military operations that were of little consideration a decade ago are now of major concern. For example, regional conflict, once considered primarily an unwelcome diversion from the primary missions of deterring and preparing to defeat Warsaw Pact armies, now is a central mission. Counter drug and counter terrorism have been military missions for only 5 and 15 years respectively. Peace keeping and peace enforcement, considered inappropriate for U.S. Armed Forces in a bipolar world, have now become major concerns. The relative importance of each of the two dozen or more forms of OOTW is in flux as the nation struggles to identify its role in the new political order.

Given the dynamic rate of change in the strategic environment, it is important that ARPA consider the SWG's findings, however valid now, as neither all encompassing nor immutable. These findings are valid today, but require increased caution in application as time passes. *To ensure currency, ARPA should proceed in this initiative in close coordination with the user and periodically revisit the subject, using whatever means best meets its needs. Feasible approaches include: in-house, government, or academic*

research; in-house or external analysis; working groups (such as the SWG); and contracted subject-matter experts. Regardless of the means selected, ARPA's goal should be to gain an accurate perception of the technology related requirements arising out of the development and interplay of doctrinal and operational shifts resulting from changes in the strategic environment.

Conclusions

The SWG concluded that:

- The predominance of future military missions will involve OOTW
- Soldiers and small units must be adequately equipped, trained, and supported for OOTW
- The urgent requirements identified in this report are of national-level importance
- Certain needed capabilities are possible only through breakthrough technology
- Many technologies developed for OOTW are also applicable to other government and law enforcement agencies
- Public perceptions and policy decisions are influenced dramatically by the perceived performance of military forces in OOTW.

Recommendations

The SWG recommends that ARPA:

- Aggressively pursue the development of breakthrough technologies identified as satisfying urgent OOTW needs
- Leverage improvement in legacy systems and foreign technologies to maximize force readiness for the near-term
- Facilitate development of a long-term national plan for science and technology to meet identified needs
- Assist in the hand-off of promising technologies from demonstration to production and fielding

- Establish a mechanism to periodically monitor program implementation and to identify emerging OOTW requirements.

I. INTRODUCTION

A. Senior Working Group Charter

The SWG was convened to assist ARPA in identifying OOTW unique requirements for which the application of advanced technology would make a significant contribution. The charter given the SWG was to:

> Assist ARPA in the *development of a vision* and *implementation plan for development of advanced technologies* to *enhance effectiveness and survivability* of U.S. forces engaged in *OOTW*...

Specific tasks given the SWG included: reviewing potential missions; identifying key problem areas; defining technology options; and recommending a strategy. While the SWG's focus was long-term, it was also directed to examine key near- and mid-term enabling technologies. At the conclusion of this effort, the SWG was directed to provide ARPA with this report containing:

- A vision statement for the proposed ARPA initiative, including a definition of OOTW
- Rationale supporting this proposed initiative that assesses requirements and technology
- Program recommendations with rationale that addresses new systems technologies.

The SWG Terms of Reference are provided in Appendix A.

B. Senior Working Group Composition

General Carl Stiner, U. S. Army (Retired), chaired the SWG. General and Field Grade Officers representing every branch of the Armed Forces and representatives of the national intelligence and law enforcement communities comprised the SWG. Members' backgrounds reflect extensive experience in special operations and combat in low- and mid-intensity conflict environments, and participation and experience in a broad range of

OOTW, intelligence, law enforcement, and security. Colonel Justin Holmes (U.S. Army Retired), of MITRE, was included in the panel primarily because of the critical importance of communications in accomplishing OOTW. The members of the SWG, and their most relevant background, were:

General Carl Stiner, USA (Ret.)—Infantry, Airborne, Special Operations

Chief of Police Isaac Fulwood, Washington, Washington D.C., (Ret.)—Drug Law Enforcement Agencies

Dr. Sayre Stevens, CIA (Ret.)—Intelligence related technologies

Major General Joe Lutz, USA (Ret.)—Cavalry (reconnaissance), Airborne, Special Operations

Major General Orlo Steele, USMC (Ret.)—Infantry, Federal Aviation Administration

Colonel Scot Crerar, USA (Ret.)—Special Operations

Colonel Mercer M. Dorsey, USA (Ret.)—Infantry, Airborne, Special Operations

Colonel Justin Holmes, USA (Ret.)—C4I

Captain Mike Jukoski, USN (Ret.)—Navy Special Operations

Colonel Keith Nightingale, USA (Ret.) —Infantry, Airborne, Counter Drug

Lieutenant Colonel Bill Coenen, USMC (Ret.)—CIA, NSA

Major Skip Davenport, USAF (Ret.)—Air Force Special Operations.

C. Methodology

The SWG requested and received a series of relevant briefings from industry, government agencies, and laboratories on advanced developments in the areas of weapons, mobility, sensors, communications, language, and intelligence systems that have potential OOTW application. Briefings also included updates on current military doctrine and operations and on the world-wide threat (see Appendix B). The SWG synthesized the information gained from these briefings with their personal experiences and collective knowledge, and identified those technologies with the greatest potential

payoff. The SWG also carefully considered the applicability of the selected technologies to the law enforcement community.

This consideration was the result of the SWG's recognition of the convergence in the law enforcement and OOTW environments. Several factors have led to this convergence. The threats faced by both law enforcement personnel and military forces engaged in OOTW are now very similar. Widespread availability of increasingly sophisticated weapons has intensified the threat faced by law enforcement personnel. Terrorists, narcotics traffickers, and even common criminals are today equipped and armed as well as many irregular and some regular light forces. Further, the techniques and means they employ to further their objectives are in many ways similar to those of military forces. Concurrently, political considerations which mandate limiting non-combatant and even combatant casualties and collateral damage in OOTW have resulted in increasingly restrictive military rules of engagement that are not dissimilar to those common to police operations. This convergence of operational environments results in technologies—initially focused on military needs—being applicable to law enforcement and security needs as well.

The study was accomplished in a series of ten working sessions between October 14 and November 23, 1993.

II. EVOLVING STRATEGIC ENVIRONMENT

A. Current Threat

The United States faces the demands of an exceptionally diverse and unstable world (Figure II-1). Although the threat of global war has all but disappeared with the demise of the Soviet Union, it has been replaced by numerous, proliferating, smaller, highly diverse threats that challenge the nation both politically and militarily.

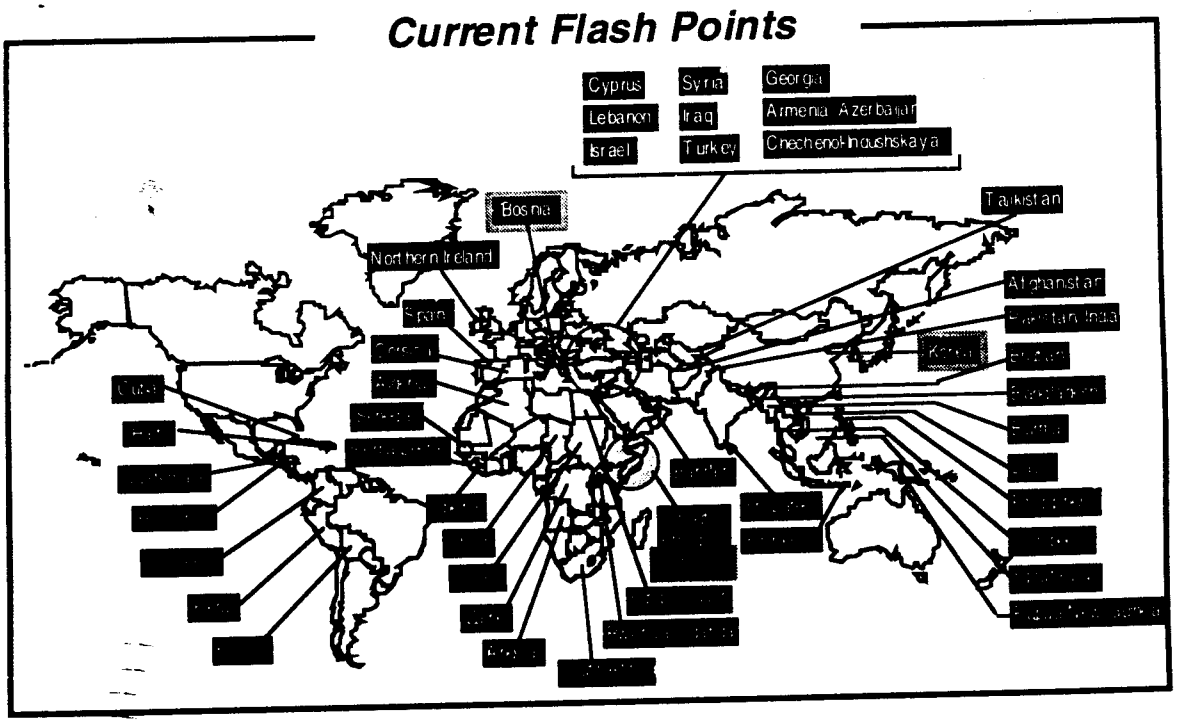

Figure II-1. The Unsettled World

While superpower rivalry during the Cold War spawned regional conflict—as the Soviet Union sought to expand its influence and the United States sought to contain that expansion—it also imposed stability. It was in neither superpower's advantage to have regional conflict escalate. Through a series of military alliances and employment of political, economic, and military means, the United States and the Soviet Union maintained a kind of "world order."

Consequent to the collapse of this world order, in many regions former strong, but often repressive, governments have been replaced with less powerful, less centralized governments in which burgeoning separatism and micro-nationalism have supplanted ideological solidarity. As a result, many formerly suppressed nationalities and linguistic, ethnic, and religious groups desiring nationality status are now free to press for their goals. Many groups have found this new political environment an opportunity for redressing long-perceived injustices or to wreak havoc on traditional enemies.

Concurrent with the collapse of this world order, there are a number of related and reinforcing trends that cause instability in the less developed countries (LDC) and offer an unprecedented challenge not only to U. S. interests, but to those of the developed world as a whole. Principal among these are:

- Population pressures on fragile environments
- Urbanization of the world's population, and the resultant social, economic, and political pressures this trend is creating in nations ill-equipped to deal with them
- The continuing and expanding gap between "have" and the "have-not" nations, leading to a perception of distributive injustice in LDC; a perception reinforced by ready access to the worldwide information infrastructure with its images of "the good life" in developed nations.

Together, these trends and nationalism tend to fuel both terrorism and religious extremism. For example, two of the major factors leading to a resurgence of Islamic fundamentalism in modern times were perceptions of European exploitation and disenchantment resulting from the failed promise of development along Western lines.

The AIDS epidemic, and its impact on the economies and leadership of underdeveloped nations, particularly in Africa, and narcotics trafficking and "narcoterrorism" are two other destabilizing factors. The recent challenge to the

Colombian state by the Medellin drug cartel is a clear example of the "military" power of narcotics traffickers. Confrontation on the Korean peninsula and the ascension of China as a regional power also offer potential threats to U.S. interest. These conditions and other factors depicted in Figure II-2, will create or foster a variety of potential specific threats to U.S. interests.

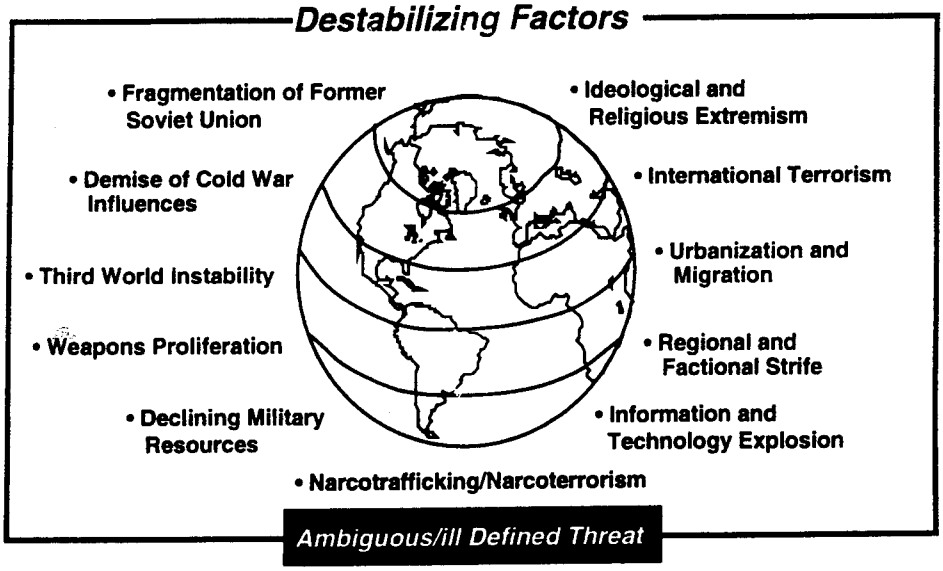

Figure II-2. Causes of Instability

B. Future Threat

There will be no general remission in the threats to U. S. interests in the near-term. The underlying problems that are their cause are long-term, complex, and in many instances either intractable or beyond the limits of the resources that the United States, other nations, or coalitions of nations are willing to dedicate to them. In relatively few instances does it appear likely that current or developing conditions will result in U.S. involvement in war. It is predictable, however, that the United States frequently will find it necessary to engage in OOTW if it is to defend its interests, assist its allies, protect its citizens and maintain its position of leadership.

C. Specific Challenges

On the positive side, there is no immediate major threat from another world power. Although Russia could be a potential future threat, it is only an immediate threat in

respect to its possession of nuclear weapons with intercontinental range. Efforts to rebuild the Russian war machine to a level where it could threaten the U. S. or its European allies would require such massive resources and time that the effort would provide lengthy warning to the West. Other former Soviet republics such as the Ukraine also possess nuclear weapons. Without these weapons the republics owning them lack the ability to project power in any manner that could be considered a direct threat to the U.S. or its allies. However, until all of these weapons are destroyed or disarmed, they remain a danger for which the United States must maintain capabilities to deter or neutralize.

In the hands of outlaw groups, WMD and associated technology would pose a significant threat to world stability. This is perhaps the most complex and serious challenge we are likely to face short of war. Further, the United States is also no longer free from terrorism on its own soil, as is evidenced by the recent bombing of the World Trade Center.

China, even if it maintains its current government stability and its rapid economic development, will be no more than a regional power. It will, however, for the foreseeable future, be a major power in an unstable region where the United States has great economic interests and a number of defense commitments.

The most likely threat of U.S. involvement in war is found on the Korean peninsula. North Korea, both because of its nuclear potential and its proximity to Japan as well as South Korea, poses a potentially serious threat to U.S. interests that may lead to U.S. involvement in a major regional conflict.

As the political world becomes increasingly fragmented and tumultuous, the demands to employ the nation's military forces in OOTW will increase. These operations will be highly diverse in character and may be conducted amidst the challenges associated with the threat of WMD. The objectives of these employments will encompass a wide range of missions including: "showing the flag;" humanitarian assistance;

deterrence; rescue of U. S. citizens abroad; and establishing, enforcing and supervising conditions of peace.

D. Current U.S. Military Capabilities

As evidenced by the conduct and results of the Gulf War, the United States recently possessed the world's preeminent military force. This force, however, is rapidly declining in both numbers and capability under the impact of drastically reduced budgets. The impressive technology edge enjoyed by the U. S. Armed Forces is eroding as the equipment providing that edge grows obsolescent without next generation replacement, while other nations, duly impressed by the Gulf War, modernize their forces.

Although also applicable to major regional contingency requirements for the future, Table II-1 lists key problem areas or capability shortfalls that will affect mission success in OOTW.

- **Inadequate nuclear/biological/chemical detection in non permissive environments**
- **Inadequate capabilities to detect, locate and neutralize bunkers, tunnels, and underground facilities**
- **Limited secure, real-time C2 to lower echelon units**
- **Limited operational intel/collection/dissemination**
- **Inadequate mine/booby trap/explosive detection**
- **Inadequate non-lethal capabilities for equipment and crowd neutralization**
- **Limited non-intrusive drug detection**
- **Inadequate OOTW modeling and simulations for training, rehearsals, and operations**
- **No real time common language voice recognition translation capability**

Table II-1. Key Problem Areas and Shortfalls

Two of the major capabilities U.S. forces must have to effectively prosecute OOTW are strategic deployablity and the ability to discreetly apply force. In the future, as U.S. forces are withdrawn from overseas and redeployed in the Continental United States

(CONUS), they will be farther from probable hot spots than in the past, dependent for critical strategic mobility on inadequate and antiquated sealift and on an aging fleet of Vietnam-era aircraft

Additionally, our forces are not designed for the discrete application of force. Our current military force structure was designed to deal with the threat posed by the Soviet Union. Our strategy, doctrine, training and modernization efforts have accordingly been driven by this threat that required the concentrated application of massive fire power. These capabilities have limited utility in operational environments where political considerations mandate that casualties and collateral damage are kept to an absolute minimum.

E. Future Challenges

The greatest challenge to the United States in the foreseeable future will be to maintain its influence and interests in a fragmenting political world where the non-military levers of power—diplomacy, economic strength and national prestige—are much less effective. While there is a strong desire to focus national efforts, assets, and attention on domestic problems, both the United States' wide flung interests and its status as the only remaining superpower will not permit this. Allies, friends, clients, and others (including international bodies such as the United Nations) will expect and demand that in hazardous situations the United States lead the way. Accordingly, U.S. forces will perform a critical role as instruments of U.S. national policy in the future.

The primary military challenge of the immediate future is to meet the American people's expectation that their Armed Forces will be successful whenever committed. In the current environment, this requires the nation: (1) create and maintain adequate and ready forces, that are capable of full mission accomplishment in every situation to which committed; and (2) provide these forces with sufficient intercontinental and tactical mobility to permit them to responsively perform any assigned task.

F. OOTW Specific Challenges

OOTW may vary from simple disaster relief at the lower end of the spectrum of potential operations to major military intervention short of declared war or major conflict at the upper end (Figure II-3). They are not necessarily limited in scope, complexity, property cost, money, or lives. Moreover, such operations may escalate gradually or suddenly to situations of greater seriousness, complexity, importance and commitment than originally expected. Thus, the nature of a specific operation lies in the circumstances that originated the operation, the character of the opposing forces, the operation's objectives relative importance to U. S. interests, and finally, the intended outcome of the operation.

STATUS*	GOAL	MILITARY OPERATIONS	EXAMPLES	
War	Fight and Win	War	COMBAT	Large-Scale Combat Operations
Conflict	Deter War and Resolve Conflict	Other than War	COMBAT	Strikes Peace Enforcement Counter-terrorism Support to Insurgency
			NONCOMBAT	Peace Keeping Counter-Drug NEO
Peace	Promote Peace	Other than War	NONCOMBAT	Disaster Relief Civil Support Nation Assistance

** The states of peace, conflict and war could exist simultaneously in the theater commander's strategic environment*

Figure II-3. Range of Military Operations

The predominant types of military operations for the foreseeable future will be OOTW, including both combat and non-combat missions, and in some instances concurrently. Whether humanitarian in nature or involving hostilities, such operations

will most often occur overseas in LDC. Many of these nations will have only a minimal political and economic infrastructure. The commitment of U. S. forces to OOTW will most often result from the President exercising his authority as Commander-in-Chief rather than from the formal approval or endorsement by Congress. Additional unique characteristics associated with OOTW include:

- Operations will frequently be initiated with little or no notice and require rapid, adaptive planning and decision making
- Such operations typically will have great political impact in both the domestic and international arenas and will be conducted in full view of unrestricted world news media
- The United States may not be in charge: its forces may be part of an alliance, coalition or UN force, or they may have limited functions such as air or logistic support
- The Department of State or an international body such as the United Nations will probably exercise a constant and controlling influence on military operations. Because these operations are usually taking place concurrently with diplomatic efforts, the military commander will often be limited in his actions and in the tactics and force that his units may employ
- Operations will normally be contingency in character, temporary in nature, and conducted with the objective of restoring peace and stability, and improving conditions as rapidly as practicable with the minimum application of force

Unlike war, military operations in urban areas will figure prominently in OOTW. Except for domestic operations, centers of gravity in OOTW—the source of power, the control or destruction of which is central to the successful prosecution of a military operation—most often reside in the political control of the civilian population, especially

given the pattern of development in LDC, those who live in capital cities, ports or other large urban areas. This is less often the case in war. Consequently, whereas in war urban areas are bypassed whenever possible because of the cost involved in taking and controlling them, in OOTW bypassing these population centers will usually not be possible.

In OOTW, U.S. forces will normally be operating in environments characterized by marked differences in language, culture, and religion from what they are used to—not only with respect to the indigenous population, but also regarding other members of the coalition force to which they may be assigned. Even nations with similar customs and language, such as the U.S. and Great Britain, differ somewhat in military doctrine and the conduct of operations.

Understanding and respecting local customs is vital to the success of OOTW because close contact with civilians is a critical facet in almost every form of these operations. All ranks, and especially unit leaders, must become familiar with the language, geography, and the political, cultural and religious factors that prevail in the country of operations as early as possible and preferably before deployment. Violations of local customs or psychological errors, no matter how innocently committed, may have far-reaching, adverse effects and may require a long period to re-establish confidence, respect, and order. This inherent involvement with civilian populaces of different cultures places a high premium on human source intelligence, psychological operations, and civil affairs operations.

Because of this civilian-military intermixing, distinguishing those who actively oppose our presence—the "enemy"—from the large mass of uninvolved civilians will be exceptionally important and usually extremely difficult. In clashes between troops and the local populace, identifying and taking actions that are appropriate, effective, and acceptable to domestic and international observers may be the single greatest challenge.

While opponents to our presence may be comprised principally of "irregulars," given the proliferation of state-of-the-art weaponry over the past decade, it is highly likely that they will be as well armed as our own forces. Further, in operations such as peacekeeping and humanitarian relief where "friendly" forces may be widely dispersed in small detachments, irregular forces often enjoy the advantage of being able to concentrate superior numbers at the time and place of their choosing. They have the additional advantages of a thorough knowledge of the surrounding terrain and often the support infrastructure afforded by the local population. OOTW operations by their nature provide greater risk for surprise, deception, ambushes, etc., than in conventional operations.

Finally, very careful consideration must be given to how the force is trained, task organized, and phased into the area of operations. In most cases, other than disaster relief, highly mobile light infantry will form the predominant arm in OOTW. That is not to suggest that combat support and service support elements necessarily play a lesser role. Indeed, light forces, by their nature, need to have a wide array of combined arms and other capabilities at their immediate call should the level of hostilities suddenly escalate. Because (1) U. S. intent will be to achieve its aims with the least amount of force, and (2) security of the force is a matter of prime concern, off-shore mobile or semi-permanent sea-based platforms are an attractive means to position these contingency capabilities in-theater.

Thus, in OOTW we face an all-too-frequent need to deal with resolute adversaries that:

- Employ increasingly advanced weaponry
- Use terrorist or guerrilla tactics, including:
  - -- surprise
  - -- night operations
  - -- snipers, mines, booby-traps, and other forms of deadly mischief

- May have the support of significant segments of the indigenous population, which:
  - -- provide intelligence on U.S. forces
  - -- provide cover for their operations
  - -- give protection to their leaders and forces
  - -- create a climate of resistance and non-compliance
- Have unique knowledge of the environs, the indigenous culture, and the local power structure
- Understand and exploit peculiar U.S. force vulnerabilities:
  - -- the strong political sensitivity to the commitment of U.S. forces abroad
  - -- an inability of sustained operations
  - -- the scrutiny of U.S. forces and operations by a ubiquitous media presence.

Our forces are now, in many regards, neither well equipped nor adequately trained to deal with these difficult circumstances.

Identifying these shortfalls in equipment and training was a major concern of this effort. The SWG's deliberations were illuminated by briefings on current and recent OOTW experience, on the views of responsible commands as to their needs for improved capabilities, by recent reviews of military technology quite separate from this study in which nearly all members had participated, and by knowledge gained through experience with many operations over many years. The shortfalls and vulnerabilities identified as the result of these deliberations guided the search for and selection of technological opportunities to support OOTW missions. These opportunities are individually identified and discussed in Section III.

OOTW are the military operations of today and for the foreseeable future. These operations cannot be prepared for and conducted at the expense of the Armed Forces'

preparedness for deterrence and the conduct of war; however, U.S. forces must be able to execute quickly and effectively the missions encompassed in OOTW and bring them to a successful conclusion. The forces required may be fewer, and the discernible threat to our nation may be less obvious than in war, but the ultimate significance of success is no less. Success in these missions may not be recognized as victory, but failure may have far-reaching adverse political and economic ramifications.

III. ADVANCED CAPABILITY REQUIREMENTS

A. Vision

The SWG viewed OOTW as encompassing the predominant forms of future U.S. military operations at least well into the next century. Despite the relatively modest scale of the operations normally associated with OOTW, it will be predominant in frequency, political impact, and long-term importance. These operations will initially reflect their political environments, and then change and redefine them. In order for the nation to succeed in these operations, it is imperative that the Armed Forces be adequately equipped, well supported, and well trained both as individuals and as units. The SWG envisioned the ARPA initiative as a means of providing to the military commander, through the application of advanced technology, those capabilities necessarily for the more effective employment of military force in OOTW; particularly with respect to accommodating the politically based mandates to keep casualties, both U.S. and others, to an absolute minimum.

As previously discussed in Chapter II, the probable opponents in most foreseeable non-domestic OOTW will be irregular forces: terrorist, paramilitary, militia, or national forces operating in an irregular or deniable mode. These forces may well have unprecedented access to highly potent and sophisticated weaponry. At this revolutionary turning point in political and military affairs, it is of vital interest that the Armed Forces identify and implement the major changes required to appropriately meet the challenges of a markedly altered worldwide political environment.

Developing and fielding the technologies advocated in this study are offered as one of the few available options for providing value-added capability to U.S. Armed Forces that will be engaged in OOTW. The path that such developmental efforts should take is reflected Figure III-1. It includes:

- Identifying OOTW-unique requirements, in close cooperation with the user.

- Next, identifying those requirements not adequately met by conventional military capabilities, and determining which of those requirements can be addressed by technology .
- And finally, determining those requirements for which there are no existent, or developmental, technology solutions .

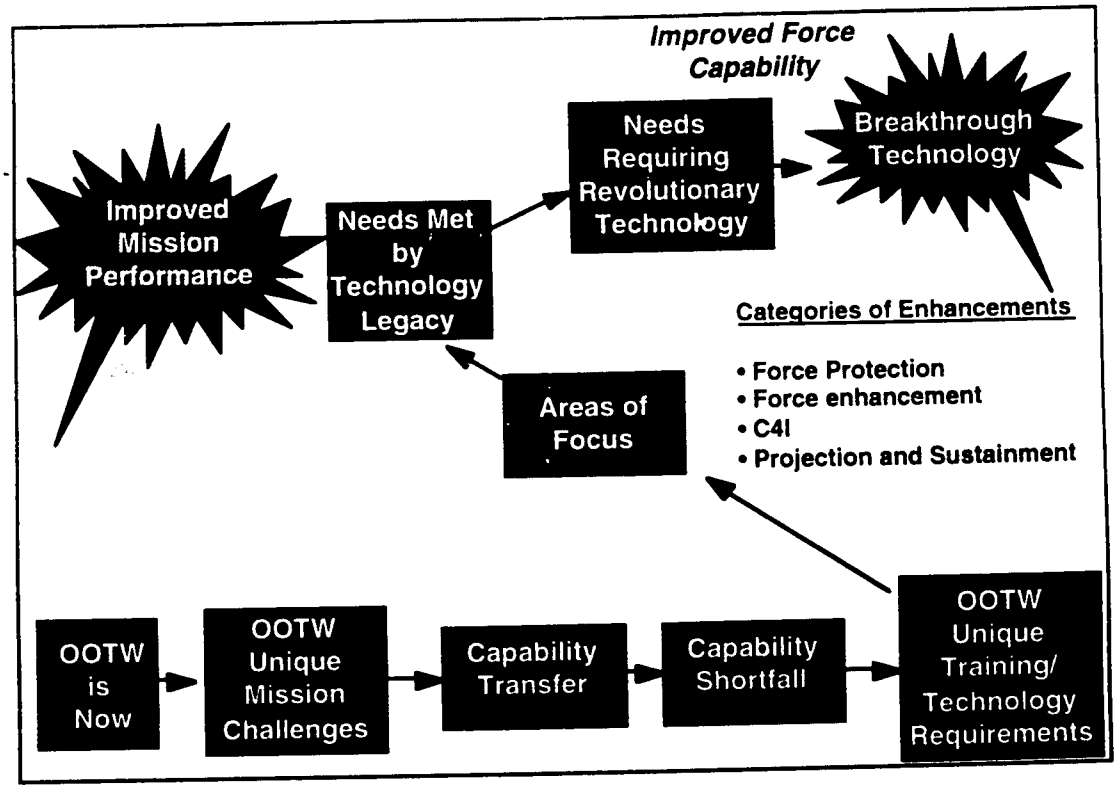

Figure III-1. Vision Thrust

Simply better applying existing and developmental technologies to OOTW-unique requirements should lead to improved mission performance. Breakthrough technology, on the other hand, may result in a leap in capability.

B. Advanced Capability Requirements

This section identifies the technology areas that have the greatest potential for providing significant added value for OOTW. These were selected from a much longer and diverse menu to provide focus for further development. The recommendations, although selected because of their exceptional high added value in OOTW, will also

improve United States forces' capabilities for war and, in many instances, have important applications to other government and civilian organizations, particularly in law enforcement. The recommendations range from technologies that are critical to the protection of entire cities—by the remote tactical detection of WMD, to those which will protect single or small groups of soldiers—by the detection of a mortar round in flight to warn them or to limit or neutralize its impact. The vision suggests programs of great scope, such as a modernized bio-medical treatment program, to some as basic as developing a non-lethal weapon (e.g., a sticky foam) that will temporarily incapacitate an individual. The range of technologies reflects the great diversity of OOTW

CATEGORY	FORCE PROTECTION	FORCE ENHANCEMENTS	COMMAND, CONTROL, COMMUNICATIONS, COMPUTERS, AND INTELLIGENCE (C4I)	FORCE PROJECTION & SUSTAINMENT
Priority I	• Invisible Soldier - Image avoidance - Signature reduction • Mine, Booby Trap and Explosive Detection and Neutralization	• Tactical Detection of Weapons of Mass Destruction (WMD) • Advanced Night Vision (NV) Equipment • Non-lethal Weapons Systems • Mission Kill - Area and Point	• Low-Signature Unmanned Aerial Vehicles (UAV) • Common Language Voice Recognition Translator	• Reduced Visibility Penetrator Aircraft
Priority II	• Anti-Mortar (Light Indirect Fire) Capability • Extremities Protection • Anti-sniper System	• Detection and Destruction of Underground Facilities • Non-intrusive Drug Detection	• Room Monitor • Chemical/Biological Expert System • Virtual Reality Modeling and Simulations for Training, Planning and Rehearsals	• Survival Tag and Tracking System • Combat Search and Rescue (CSAR) Command and Control (C^2) System
Priority III	• Biological-Medical Treatment Capability	• Stand-off Precision Breaching Weapons (Squad/Team) • Stand-off Neutralization of Weapons of Mass Destruction	• See-through Capability for Buildings and Structures • Strategic/ Discriminating Remote Sensors	• Universal Long-Life/ Light-Weight Power Source • Strategic Airlift Capability • Floating Sea Base Capability

Table III-1. Required Technologies.

The technologies reflected in Table III-1 were selected from a long list of potential candidates. Each addresses an important problems. However, to focus these efforts a relative priority for the application of resources was established. Priority I requirements, however long-term the development cycle is, should be addressed now. Priority II and III requirements should be developed into program initiatives as soon as technology and resources permit. It must be emphasized that these are a general rather than a detailed ordering of technology priorities.

C: Description of Required Technologies

Following are descriptions of the 27 technology requirements identified in Table III-1. Each description includes a discussion of:

- Desired capability
- Rationale
- Operational concept
- Applicability
- Related technologies.

These descriptions are broadly framed and intended only to outline the general capability required. Some related technologies are also identified, but these should in no manner be considered all-inclusive or limiting. The intent is to identify what is needed; not to specify how the requirement should be met. The SWG defers to the expertise of the research and development community to identify feasible technological solutions and the best approaches for achieving them.

PRIORITY I

Tactical Detection of Weapons of Mass Destruction (WMD)

a. **General.** This addresses both nuclear and chemical and biological WMD.

b. **Nuclear Weapons**

1) **Desired Capability.** A stand-off means for small tactical units operating in non-permissive environments to detect the location of, or assembly areas of, nuclear weapons.

2) **Rationale.** The proliferation of nuclear weapons technology has placed the production of such weapons within the capability of terrorist-supporting or unstable regimes. This capability offers ideological and state supported terrorists a means of international political blackmail. This is probably the most dangerous single threat facing the United States in the foreseeable future. It is of vital necessity that U. S. forces be able to quickly locate these weapons so operations may be conducted to secure or disable them. Celerity is the key to such operations: the weapons must be secured before the opposition is aware that there is a force in the area dedicated to this goal. Once the device is located, the force must be able to capture the site and then remove, disable, or destroy the device before its defenders can mobilize and employ a counterattacking force. Such weapons are sufficiently compact to be easily concealed in forests, jungles, rural buildings or in urban areas. Urban areas constitute the most demanding environment: compartmentation precludes rapid search, and even the threat of such a weapon's presence makes the population hostage. Current U. S. capabilities in this arena are inadequate to meet the demands of a threat that is growing in magnitude and sophistication.

3) **Operational Concept.** By means of intelligence, or opponents' threats or demands, the U. S. would likely have general knowledge of the class and nature of the weapon(s) of concern. The desired technology must permit rapid scanning of large areas to determine

the presence of the weapon. This scanning must be accomplished without alerting the force that is protecting the weapon. This could be accomplished by mounting the scanning equipment in an unobtrusive vehicle, helicopter, light aircraft, or UAV. The technology must be able to establish the location of the weapon of mass destruction in a relatively small area, such as a specific floor of a specific building. Knowledge of the weapon's approximate location will eliminate lengthy ill-defined searches and reduce associated risks to U.S. forces and facilitate mission success. The precious time available can be employed securing or neutralizing the device before the opposition can react.

4) **Applicability:** The desired technology is applicable by military organizations from national to small unit Special Operations Forces (SOF) and by national level law enforcement agencies. Under certain circumstances, the U. S. may employ this technology in support of allied military or police forces.

5) **Related Technology Areas:** Nuclear radiation detection, air sampling, infrared (IR) and radar photography.

c. **Chemical and Biological Weapons**

1) **Desired Capability:** A means for small tactical units operating in non-permissive environments *to determine the location of chemical or biological agents that are configured as, or may be used to develop, a weapon of mass destruction.* This technology must:

- Confirm the presence of the agent and verify its location to an area the size of a room or a specific building without entry into the site
- Provide on-site confirmation of the type of agent within a predetermined class (biological or chemical) in 5 minutes or less without ambiguous readings
- Be man-portable and include any required power source.

2) **Rationale.** The proliferation of chemical and biological agents offers terrorists, and terrorist states, a very cheap, technically unsophisticated opportunity to create MD as a

medium of terrorism or political blackmail or for use on the conventional battlefield. Although not perceived to be as devastating as nuclear weapons, to unsophisticated opponents these threat agents hold even greater potential as MD. It is of vital necessity that U. S. forces are able to locate these agents quickly and identify the specific threat posed by the agent. As with the nuclear threat, it is important that the agent be identified, secured, or neutralized before the opposition can launch a counter force. Such weapons are sufficiently compact to be easily concealed in forests, jungles, rural buildings, or urban areas. Highly populated urban areas, the compartmentation of which precluding rapid searches, constitute the most demanding environment. Even the threat of such a weapon's presence makes the population hostage. Current U. S. capabilities in this arena are inadequate to meet the demands of a threat that is growing in magnitude and sophistication.

3) **Operational Concept:** Friendly forces should be able to discern the class and nature of the agents or weapon(s) of concern through intelligence operations, or the terrorists' demands or threats. The desired technology should permit rapid scanning of large areas to determine the presence of the agent. This scanning must be accomplished without alerting the force that is protecting the weapon and could be accomplished by mounting the scanning equipment in an unobtrusive vehicle, helicopter, light aircraft, or UAV. The technology must be able to establish the location of the MD in a relatively small area such as a specific floor of a specific building (more precise location desirable). Knowledge of the weapon's approximate location will eliminate lengthy ill-defined searches. Therefore, the recovery force can use the limited time available solely for securing or neutralizing the weapon and withdrawing before the opposition can react. This technology will also have significant applicability to the treaty-monitoring process by providing positive location of stored weapons and of biological or chemical production facilities.

4) **Applicabiiity:** The desired technology is applicable to all counter-terrorist forces, United Nations' peacekeeping forces, treaty monitoring teams, Department of Transportation, Federal law enforcement agencies, and conventional forces occupying captured terrain.

5) **Related Technology Areas:** Spectrum sensors, chemical detection, biological detection, chemical and biological expert systems, air sampling, chemical trace detection, IR and radar photography.

Mine, Booby Trap, and Explosives Detection and Neutralization

a. **Desired Capability.** The desired technology will protect personnel, equipment, facilities, and vehicles by detecting explosives while friendly forces are at a distance, without requiring them to enter into danger areas in an environment where detection and simultaneous explosion are unacceptable. It should:

- Determine the location of explosives in any configuration—in the open, in the ground, in a building, or in vehicle—prior to the close approach or entry of conventional, counter-terrorist, or law enforcement forces.
- Accomplish simultaneous detection and neutralization of the explosive charge by fuze disablement or "soft" (non-explosive) detonation.

b. **Rationale.** OOTW often require forces to operate widely dispersed in densely populated areas against an array of ill-defined threat forces. Because they are cheap, easily employed, and widely available, threat forces have a propensity of employing mines, booby traps and explosives in a wide assortment of configurations and situations to inflict casualties on friendly forces, and to generally impede the execution of the friendly force's mission. Counter-terrorist forces must always assume that explosives are emplaced in hostage incident sites. Stand-off detection and neutralization will permit

safe passage and enhance mission execution by the operating force while minimizing the danger to non-combatants and collateral damage to vehicles or buildings.

c. **Operational Concept.** Government or law enforcement operatives will be able to detect and neutralize hidden explosives without subjecting themselves or non-combatants to the effects of intended or accidental explosions. Fully developed remote explosive detection devices will deny terrorist organizations a primary option of attack, and greatly reduce the risks of extensive casualties and mission failure by forces involved in high-risk operations. Military and law enforcement personnel will employ this capability in the full range of OOTW. This capability will also enhance the war fighting ability of conventional armed forces.

d. **Applicability.** The desired technologies are applicable to all military services, law enforcement agencies, and security services.

e. **Related Technology Areas:** Robotics, unmanned vehicles, fiber optics, display devices, air sampling, chemical trace detection, imaging technology capable of seeing through structures, magnetic, IR, acoustic and radar anomaly detection.

Mission Kill—Area and Point

a. **General.** "Mission Kill" devices are technologies that disrupt an operating system, precluding them from being able to perform their assigned function at the time or place required. These devices may be either lethal or non-lethal.

b. **Desired Capability.** A family of precision or area weapons systems that will preclude a hostile element or individual from carrying out the intended mission by disabling the individual, his equipment or his weapon with minimal or no collateral damage or casualties.

c. **Rationale.** In an OOTW environment, the killing or wounding of a hostile individual or element, or destruction of his equipment, may not necessarily be required or desired to neutralize the threat and to achieve mission success. The concept of mission kill places the focus of weapon employment on disrupting the opponents' ability to attack or inflict injury rather than on destroying people or materiel. This implies minimum force and opens for consideration a whole range of weapons systems options that may stun, dazzle, disorient, disrupt or disable people or things. Mission kill systems offer a flexible alternative to the current family of conventional munitions- and explosives-based weapons that are focused on destroying people and equipment.

d. **Operational Concept.** Mission kill systems offer an alternative attack means with much broader capabilities than standard individual and crew-served weapons. Fully developed, they could be used by dismounted troops, or troops mounted in armored vehicles, or in aircraft. They would provide the commander with an option other than conventional firearms and explosives to protect his force and to accomplish his mission. They will enhance his capabilities while reducing the likelihood of non-combatant casualties and collateral damage.

e. **Applicability.** The desired technology is applicable to all military forces in OOTW or war, to all police forces, and to numerous other government agencies such as the FBI, Secret Service, Customs Service, and CIA.

f. **Related Technology Areas.** Non-nuclear electromagnetic pulse (EMP), directed energy weapons, lasers, high-power microwave, infra sound, isotropic radiators, calmative agents, and carbon fiber conductors.

Non-lethal Weapons Systems

a. **Desired Capability.** A technique or system(s) that permit the temporary neutralization of hostile individuals or groups with no long-term debilitating effects and minimum casualties. The neutralizing effect should last at least 5 minutes (longer is desirable) and may be used in mixed crowds of combatants and non-combatants. It may take a variety of forms, including guided weapons, light, sound, gases, or aerosols.

b. **Rationale.** Friendly, non-combatant and hostile casualties have added significance in OOTW: These casualties would be considered acceptable in the pursuit of mission accomplishment during war but are often unacceptable in OOTW due to domestic and international political concerns. The introduction of non-lethal systems will provide military and police forces with benign options that are not now available for force protection and for neutralizing of hostile elements. Currently, the single course of action usually available to respond to life-threatening hostile situations is to apply lethal force--often under the restraints of restrictive rules of engagement established to limit non-combatants' casualties and collateral damage. The lack of effective but less lethal alternatives increases the risk to friendly forces and reduces options available to the commander for accomplishing the mission in the shortest time possible and on terms most favorable to the United States.

c. **Operational Concept.** These systems will be used by individuals and crews while dismounted or in vehicles or on airborne platforms. They could be applied in a whole range of potentially hostile situations to neutralize explosive situations, neutralize armed, threatening individuals in crowds, control civil disturbances or riots, and neutralize and detain individuals. These systems will offer military forces and police an option of applying the minimum force necessary to resolve a situation without resorting to lethal means--even when threatened by individuals or groups employing lethal means. This

technology would be ideal for use by hostage rescue forces, providing the ability to neutralize individuals in the target area with greatly reduced probability of hostage casualties.

d. Applicability: The desired technology would be valuable in OOTW, revolutionizing the ability of military and police forces to deal with dangerous, unstable, and potentially life-threatening situations. These systems will also be applicable in the civil sector by police and security forces, and will enhance operational effectiveness of the Armed Forces during wartime in specific mission applications.

e. Related Technology Areas. Directed, variable strength energy weapons, non-lethal gases, acoustic research, non-nuclear EMP, super caustics, aerosol nets, adhesives, and lubricants, aerosol dyes, intense light (strobe flash), and irritants.

Invisible Soldier Image Avoidance and Signature Reduction

a. Desired Capability. Make the individual soldier invisible, day or night, to the whole range of battlefield sensors across the electromagnetic spectrum.

b. Rationale. Selected OOTW missions require the penetration of non-permissive or denied areas for operational purposes such as intelligence collection, surgical strikes, or hostage rescue. The success of these missions depends on the ability of the force to remain undetected during target approach. The ultimate detection avoidance is to be invisible to the human eye and to the ever increasingly sophisticated night-vision devices and sensors that are available to all U.S. potential adversaries. Technology advancements will now permit serious exploration of this goal.

c. Operational Concept. A camouflage uniform, uniform coverall, poncho, or blanket that will conceal the soldier to the wide range of the electromagnetic spectrum. Issued to high-priority counter-terrorist, reconnaissance or police units, this item will

permit entry into a target area either undetected or imprecisely detected, greatly enhancing the probability of mission success and reducing the probability of friendly casualties. While ideally one garment would defeat all detection efforts, it may consist of a series of levels of protection based on lighting, climatic conditions, and type of threat posed. Regaining tactical supremacy at night must be given priority.

d. **Applicability.** Invisible camouflage is applicable to a range of missions in OOTW that require the entry of individuals or small units into non-permissive or denied areas. It is equally applicable to a wide range of law enforcement missions and will significantly enhance conventional operations in war, particularly ground reconnaissance.

e. **Related Technology Areas.** Active camouflage technology, active thermoelectric ribbons, IR sensors, microprocessors, enhanced light weight power sources, heat dissipation, and radar absorptive materials.

Advanced Night Vision (NV) Equipment

a. **Desired Capability.** Provide military forces and law enforcement agencies with long-range night vision equipment that will allow them to exploit the full range of their weapons systems and equipment. The advanced night vision equipment must include systems for individual dismounted personnel, (e.g., snipers) and for the crews of aircraft, vehicles, and crew-served weapons.

b. **Rationale.** Current NV equipment is excellent compared to what was available just a few years ago, but it has numerous limitations of range, weight, power, and in the user's ability to maintain spatial orientation. Further, the world-wide commercial proliferation of early generation NV equipment has ended the United States' preeminence in this field

c. **Operational Concept.** Users of NV devices (infantrymen, vehicle and air crews) should be able to conduct operations without loss of direction, depth perception, peripheral vision, or spatial orientation. Improved NV capabilities should permit accurate

use of direct-fire small arms (e.g., sniper rifles) out to 1,000 meters, and of mounted and dismounted weapons systems to their maximum effective ranges.

d. **Applicability.** This technology will be used in OOTW or war by ground reconnaissance units, special operations forces, rotary and fixed-wing air crews. It has wide potential application by law enforcement agencies, particularly in counter drug, counter terrorist, and border control operations.

e. **Related Technology Areas.** Light-weight power sources, solar batteries and charging systems, optics, IR, lasers, and light amplification.

Reduced Visibility Penetrator Aircraft

a. **Desired Capability.** The application of appropriate reduced visual and radar visibility and reduced sound technologies to penetrator aircraft that are capable of inserting and retrieving troops and equipment in denied areas. The modified aircraft must present minimal or no signature.

b. **Rationale.** Many OOTW require penetration of sophisticated air defense systems for the insertion of ground units into denied areas for intelligence collection, hostage rescue missions, surgical strikes, and raids. Surprise is key to the success of these operations, and detection during infiltration is one of the greatest risks. Current military aircraft that directly support these operations are essentially conventional air frames with special systems that provide extended range and precise navigation. These aircraft rely on a complex combination of low-level tactics, deception and radar-defeating and avoidance devices to accomplish their missions. Applying advanced visibility and noise reduction technologies will significantly enhance aircraft operational capabilities and survivability and probability of mission success.

c. **Operational Concept.** These modified aircraft will be used in OOTW for a variety of operations: raids, hostage rescues, surgical strikes, intelligence collection, and other

clandestine operations. A design that significantly reduces aircraft signature will increase the probability of success during critical phases of these operations. Such aircraft may eventually replace conventional aircraft that support a wide variety of tactical missions of conventional, airborne, and air-assault units.

d. **Applicability.** The desired technology is applicable to all conventional and special operations forces across the range of OOTW and war, to government agencies conducting covert operations, and to some law enforcement agency operations (e.g., counter drug).

e. **Related Technology Areas.** Absorptive materials, noise abatement technologies, quiet rotor blades, propulsion systems, and radar non-reflective materials.

Low -Signature Unmanned Aerial Vehicles (UAV)

a. **Desired Capability.** A UAV that, while not necessarily completely transparent to the electromagnetic spectrum, has reduced visual, audio and electromagnetic characteristics that will reduce the probability of detection and attack.

b. **Rationale.** The employment of UAVs by U. S. conventional and special operations forces will increase in all war and OOTW environments. Miniaturization and other technological advances will expand their capabilities to include even greater utility in various forms of reconnaissance, intelligence gathering, chemical testing, communications applications, and deceptions. The wide publicity about their use in combat by various countries and their relative low cost as compared to most aerial observation platforms ensure both their continued proliferation and an ever-increasing defensive consciousness of them among potential opponents. As both the effectiveness and knowledge of UAV capabilities increase, so will countermeasures and the willingness of opponents to expend assets to destroy or neutralize them.

c. **Operational Concept.** UAVs will be employed to provide intelligence, communications, and other assistance to commanders in all war and OOTW

environments. Technologies that will reduce UAV visibility to human observation and to multi-spectral detection devices will provide greater concealment and reduced vulnerability. While complete multi-spectral camouflage would probably be either technologically unattainable or prohibitively expensive, reduced visual, audio, and radar visibility are affordable and will provide the U. S. forces with major advantages.

d. Applicability. The desired technology is applicable to all conventional and special operations military and naval forces in both war and OOTW. There are also applications in the areas of law enforcement, forest management, environmental protection, and conservation.

e. Related Technology Areas. Low- or non-reflective radar materials, propulsion systems, noise abatement technologies, aircraft and glider construction, battery technology, solar power technology, and advanced camouflage.

Common Language Voice Recognition Translator

a. Desired Capabilities. In real time, translate English language voice conversation into foreign language voice (and vice-versa) in any combination desired. The automated capability to support the translation of major and minor languages should be developed on the basis of the likelihood of U.S. involvement in the areas where the languages are spoken.

b. Rationale. This is the age of coalition warfare and worldwide military involvement in OOTW. The ability to communicate clearly and succinctly in operational environments with allied and coalition forces and with current and potential adversaries is imperative to mission success. The United States, though nationally pluralistic, does not have the range of native or learned linguists in its military forces to meet OOTW linguistic requirements. Military benefits of such a capability include effective

interaction with allied, coalition, and host-nation forces and facilitated intelligence, civil affairs, psychological operations, and military training.

c. Operational Concept. Employ an automated capability that would recognize, understand, and translate voice both to and from the English language and transmit it over standard communication media. Simple software changes would enable the interface of different languages with English.

d. Applicability. In addition to military applications, the desired technology has applications to the Departments of State, Justice, Commerce, Education, and to institutions such as the Peace Corps, World Bank, and International Monetary Fund (IMF) revolutionizing how they do business. Commercially, its impact on the world marketplace could be astronomical.

e. Related Technology Areas. Speech recognition, speech understanding, speech synthesis, speech-to-speech translation, and dialogue management.

PRIORITY II

Detection and Destruction of Underground Facilities

a. **Desired Capability.** A means to detect the presence of underground tunnels or cavities of significant size in both permissive and denied areas. Upon detection, identify and characterize the underground facility as to size, depth, likely use, and estimated protective hardness. Map the underground structure and locate vulnerable points such as entrances and vents with sufficient precision as to allow the informed targeting of these vulnerable points. Technology should permit examination to depths of 100 to 500 feet.

b. **Rationale.** The construction of underground structures used for different military and government purposes has accelerated dramatically in recent years (e.g., Iraq, Cuba, and North Korea). Growing awareness of the capabilities of overhead reconnaissance and of the protective efficacy of underground structures, plus dramatic improvements in excavation and tunneling equipment, have increased dependence upon underground facilities to provide protection. Underground structures may be used as weapon caches, C4I facilities, other military or industrial facilities, and infiltration routes into friendly (U. S. or allied) installations. Awareness of their presence and knowledge of their characteristics will, in many cases, become indispensable to the successful execution of countermeasures.

c. **Operational Concept.** An operational concept can only be outlined after the technological approach(es)—or at least the sensed phenomena to be employed—are identified and defined. Ideally, search for underground facilities can be conducted by overhead reconnaissance platforms and aircraft that can conduct broad area searches with subsequent exploitation of the data collected. Ground-penetrating radar, multi-spectral imagery, passive detection, or IR imagery might support such an operational concept. Seismic or acoustic array technology, on the other hand, would appear to require either

air-dropped sensors or a presence on the ground to emplace sensor elements. Investigation of suspected underground installations for targeting is likely to require a number of technologies and technological approaches, some requiring at least a temporary local on the ground presence.

It is essential that usable information be readily accessible to the commander on the ground who is contending with the problem or the threat. The selection of neutralization techniques should be guided by the characteristics of the facility and the degree of friendly control of the area in which it is located. In some instances, external weapons delivery support (e.g., laser target designation) may be required. Information, once acquired, should be formatted for storage in appropriate databases.

d. Applicability. In addition to the obvious military applications in OOTW and war, this capability would be of value to many levels of government and to agencies with many different responsibilities, particularly in mine rescue and disaster relief operations.

e. Related Technology Areas. Radar technology, seismology, solid state imaging arrays, acoustic sensor technology, digital signal processing, image processing, ultra wide band, high-power signal generation, Geology, mining, and magnetic anomaly detection.

Anti-Mortar (Light Indirect -Fire) Capability

a. Desired Capability. A system that provides for the detection and precise location of hostile indirect fire weapons (principally mortars) in sufficient time to provide warning to friendly forces and to engage the weapon with precision weapons. The system would optimally include the capability of neutralizing rounds at time of launch or in flight before impact.

b. Rationale. Aimed or random mortar or indirect fire artillery rounds launched from positions located in urban or densely populated areas take on added significance in OOTW. These weapons are a major cause of damage to fixed facilities, high-value

targets, and a significant cause of personnel casualties among friendly forces. Current counter mortar radar do not provide the speed of detection or precision necessary to engage the weapon nor do the available response systems provide the ability to successfully neutralize fires under the restrictive rules of engagement typical of OOTW.

c. **Operational Concept.** This device should be capable of immediately detecting a high angle-of-fire round in flight, and identifying its point of origin before the round has reached its apex. It should be transportable in light vehicles and deployable in ground-mounted configurations to protect high-value targets. The minimum capability required will be to provide the user with sufficient warning to take protective measures and to provide the firing location within 10 meters of the hostile weapon in less than 10 seconds. Optimally, this device could be remotely coupled with a response weapons system that would disable or destroy the round in flight by some means. The location of the hostile weapon must be identified quickly enough to neutralize the weapon before the crew has shifted position, and must be precise to the degree necessary to engage the target in an urban environment with precision weapons with minimum collateral damage or casualties to non-combatants.

d. **Applicability.** The technology required would be applicable to countering all indirect-fire systems. Because of the high prevalence and effectiveness of hostile mortars and other light indirect-fire weapons in these operations, it will be extremely valuable in OOTW. It is applicable to all ground-based forces and would enhance force protection and counter-fire operations across the range of military operations, including war.

e. **Related Technology Areas.** Radio Frequency (RF) detection devices, radar, acoustic sensors, high-speed computers, and airborne (UAV) sensors.

Extremities Protection

a. Desired Capability. Develop individual protective armor for the human body's extremities to be coupled with existing or developmental body armor to protect the soldier from common injuries (those produced by shell fragments and small-arms fire) while allowing full mobility without degradation of combat capability.

b. Rationale. Partially attributable to the advances in and increased use of body armor, a large portion of the casualties occurring in OOTW are the result of extremity wounds that usually reduce unit operating strength and sometimes cause fatalities. Body armor technology, while advanced, has yet to offer effective protection to the extremities without unacceptably hindering combat effectiveness. In OOTW, the soldier is exposed to indiscriminate attack throughout the operational area regardless of his specific job because of the ill-defined nature of the operational environment and the fluctuating levels of hostility of the threat. The soldier is often denied the standard self-protection measures available on the conventional battlefield, such as armored vehicles or shelter in buildings or fortifications.

c. Operational Concept. Extremity protection will be provided by a light-weight, highly flexible anti-ballistic material that will protect the soldier against grenade, mortar, and light shell fragments and small arms' rounds. This protection must permit the soldier to conduct activities without degradation as a result of rigidity, excess body heating, or weight. Ideally this garment, when coupled with advanced body armor, will significantly reduce disabling or fatal injuries to troops involved in all levels of military operations.

d. Applicability. The desired technology is applicable to all U. S. forces conducting OOTW or war, and to law enforcement personnel for specific missions. This concept may have additional applicability in protecting key government personnel requiring exceptional protective measures in peacetime.

e. **Related Technology Areas.** Body armor development, camouflage technology, textiles, multi-spectral camouflage, and heat venting and transfer.

Anti-Sniper System

a. **Desired Capability.** A system that provides the ability to immediately identify the source and nature of small-arms fire directed at a friendly target and the capability to immediately direct lethal or non-lethal weapons or passive sensory devices to the source. This device would be mounted on vehicles, in helicopters, on buildings, on the ground, or hand-carried. It would react immediately to any small-arms fire directed toward friendly forces with the purpose of pinpointing the source of fire for directed or automatic neutralization or identification before the shooter being able to withdraw. This capability will reduce friendly casualties, non-combatant casualties, and sniper effectiveness, and deter sniping and other casual firing at friendly forces.

b. **Rationale.** A major threat to forces engaged in OOTW is sniper or other small-arms fire originating from a concealed position in a forest or jungle, from a densely populated area, or from within a crowd of non-combatants. Current detection capability is only as accurate and quick as human sensor perceptions and reactions. Most often, they are too inaccurate and slow to immediately pinpoint the source of fire or to preclude the shooter from taking evasive action. Response options are usually limited restrictive rules of engagement designed to limit non-combatant casualties and collateral damage.

c. **Operational Concept.** The anti-sniper system should consist of a self-contained detector device that instantly identifies the source of small-arms fire, coupled with a target designator that provides the user with the precise azimuth, elevation, and range of the origin of the fire. It should provide an electronic and "hardcopy" record of the flight of the round. Optimally, rules of engagement permitting, the device should have the capability of being linked to a weapons system that will return fire with pinpoint accuracy

with little possibility of collateral casualties or damage. The device will be employed on vehicles, on buildings, on airborne platforms, or with dismounted patrols. The device will allow instant and precise elimination of hostile shooters and will deter sniper activity. It may also be employed by law enforcement agencies for personal security and could be employed remotely to monitor high-crime areas in conjunction with cameras or other sensing devices to provide a record of firearms' activity for use in case prosecution.

d. Applicability. This capability will represent a singularly significant breakthrough for ground forces. It is applicable to all military ground forces in OOTW and war, all law enforcement in the execution of daily activities, and all government VIP protection agencies.

e. Related Technology Areas. Acoustic sensors, IR sensors, microprocessors, laser target designators, and aim point designators.

Room Monitor

a. Desired Capability. A means to monitor the activities occurring in a room without the need for access to the room's outer walls or to the room proper to emplace devices or sensors. The room being monitored must not be readily detectable or countered by subjects within the room. Optimally, it will be able to operate from short stand-off distances (e.g., from a building or vehicle across the street, from the roof of the subject's building). The greater the stand-off distance is, the better. At a minimum, the device should be transportable and operable from a light vehicle and, optimally, it should be person-portable. It should also be capable of being powered by multiple power sources (e.g., vehicle, battery, multi-voltage commercial).

b. Rationale. In many OOTW, including counter-terrorism, counter-drug and counter-proliferation, there is a need for friendly forces to know what is happening within an enclosed room. The specific requirement is to know exactly where individuals and

major obstacles are located; whether people are seated, standing or lying down; in which directions they are facing; and whether they have weapons. Additional capabilities such as immediate detection of movement and intercept of voices are desirable, but not essential.

c. **Operational Concept.** This capability will provide the friendly force (military or legal enforcement agencies) with the critical information needed to make decisions on whether to and when to assault a room containing hostages or illicit activities. Critical information required includes location of hostages or non-threatening bystanders, armament and disposition of hostile forces, and location and activities of the hostile forces' probable leader. This capability would permit friendly forces to act when opposition was least alert and capable of defense.

d. **Applicability.** This capability would have limited applicability in conventional war operations but would be valuable in a wide range of special operations and law enforcement scenarios.

e. **Related Technology Areas.** Radar, IR, heat, metal, and movement detection, power technologies, photography, micro-seismic technologies, and audio technologies.

Chemical/Biological Expert System

a. **Desired Capability.** An expert system that may be interrogated by units in the field to immediately identify a chemical/biological agent encountered. The system should provide the users with required critical information on the agent's identity, immediate protective measures, appropriate antidotes, and handling instructions.

b. **Rationale.** While a great deal of information is available on chemical and biological agents, it is not assembled in a universal, easily accessible database. Nor are the field sampling equipment and techniques and communications provisions adequately developed. Each instance is addressed in isolation and no means exist to expeditiously

verify, or rule out, the presence of toxic materials among newly encountered substances in the operational area.

c. **Operational Concept.** The expert system, consisting of analysis instruments in the field with data connectivity to the database, would: (1) verify the presence of dangerous chemical or biological agents, (2) identify the agent, and (3) outline protective, antidote, and handling measures. This system could be interrogated from the field by special operations forces and treaty-compliance units to verify suspected chemical or biological weapons, storage, and manufacturing sites. It would be used by all conventional forces as part of their nuclear, bacteriological and chemical identification and protective systems.

d. **Applicability.** Satisfaction of this requirement fills the stated major identification needs of military forces and of civilian agencies responsible for countering terrorist threats.

e. **Related Technology Areas.** Database technology, chemical weapons and detection, biological weapons and detection, data transmission, micro processing, artificial intelligence, automated analysis, and low probability of detection communications.

Non-intrusive Drug Detection

a. **Desired Capability.** The ability to identify the presence of illicit drugs, primarily cocaine and heroin, in various preparatory and final states, without being in proximity of its location.

b. **Rationale.** The counter drug interdiction mission is one of the most technically demanding missions in OOTW. Interdiction operations are conducted both in (1) isolated, underdeveloped areas of the world where drug products are grown and processed, and (2) during their inter- and international transshipment. The ability to detect the presence of drug products, their intermediate states, or their precursor

chemicals would permit more effective employment of military and law enforcement agency forces in interdiction operations.

c. **Operational Concept.** The drug detection system should consist of a device that by some means (chemical, visual, or multi-sensor) detects drugs without the necessity of entering their immediate environment (e.g., room, shipping container, laboratory). In its initial development, it should detect drugs within containers to which external access is possible (e.g., international shipping containers). Its use would permit Coast Guard or law enforcement agencies to quickly examine thousands of containers on ships at sea or in U.S. ports. Subsequent development should permit the operator to determine the presence of drugs while passing by buildings. Ultimate development would permit detection of jungle laboratories from aircraft (fixed wing, rotary wing, or unmanned aerial vehicle) without the need for the aircraft to land, circle, or loiter.

d. **Applicability.** This technology would be initially applicable in counter-drug operations by military and LEA forces. Its future development would permit use in detection of other dangerous or illicit substances (e.g., manufacture or storage of chemical weapons and explosives).

e. **Related Technology Areas.** Radar, chemical spectrum analysis, gaseous and nuclear diffusion analysis, and air sampling technologies.

Survival Tag and Tracking System

a. **Desired Capability.** A tagging system that permits remote tracking of individuals, vehicles, or equipment. Minimally, the system must provide the means of remotely locating the individual or item of interest. The tag must be configured so that it will be undetectable to captors because hostages or POWs usually undergo a thorough strip search and are forced to wear captor-provided clothing. Optimally, this device will

provide a positive location and be "readable" from high-altitude aircraft or satellites as well as from near (3 to 5 km) hand-carried monitors.

b. Rationale.

1) Human Tag and Tracking. In OOTW, the taking of political hostages by a terrorist or dissident group is a tactic that immediately provides inordinate attention, publicity and political significance to that group. Release of the hostages is generally achieved by acceding to the demands of the terrorist organization or by military or police force rescue. The inability of government authorities to mount a rescue operation is often viewed as impotent, further enhancing the terrorists' stature. Failed rescue attempts cause political embarrassment far beyond the significance of the individual event. Positive location of hostages or captives remains the key intelligence element upon which the success of any rescue attempt depends. There is a critical need for an unobtrusive individual tracking tag for high-risk personnel that will provide a positive location by a means not discernible to their captors.

2) Vehicle and Cargo Tag and Tracking. A perhaps less complex problem, but one of significance, is the requirement of a similar device that, once emplaced, will provide positive locations for vehicles with willing or unwilling occupants and cargo, particularly contraband drugs or weapons.

c. Operational Concept. Individual Tracking Tag for Personnel. Personnel at high risk of capture in war or by terrorists would be equipped with this tag. The tag system must be unobtrusive and undetectable, withstanding even the most thorough personal search. The tag should be "interrogatable" by remote satellite airborne sensors or terrestrial sensors to provide a positive pinpoint location within 50m of the individual without alerting the captors.

Vehicle and Cargo Tracking and Tag. The tag will be emplaced in vehicles and cargo to provide positive tracking through non-permissive environments providing

authorities with a means to trace contraband routes, locate key warehouses or facilities, and, by the presence of these items, to detect ongoing or planned criminal activities. In permissive environments, this system will also provide a positive location of law enforcement vehicles or cargo during shipment. An unobtrusive vehicle and cargo tracking system has tremendous potential for military, law enforcement, and commerce applications.

d. Applicability. The desired technology is applicable to the military, the Department of State, law enforcement agencies (LEA), and all branches of government that are required to place individuals in areas of high risk of capture by terrorists, criminals, or dissident factions.

e. Related Technology Areas. Global Positioning System, space-based positioning tracking system, microprocessors, biochemical tracers, mini-power sources, and electronic tags.

Combat Search and Rescue (CSAR) Command and Control (C^2) System

a. Desired Capability. A tagging system or an emergency communications system for downed pilots, special operations forces, or other military personnel at high risk of capture that will provide an immediate and precise location, security status, and physical condition. This would facilitate rescue or the provision of assistance in non-permissive areas. The system could consist of a miniaturized transceiver for the downed pilot and a receiver system adaptable to a variety of aircraft, including high-performance aircraft.

b. Rationale. Current CSAR systems are antiquated, unsecure, and imprecise. Even recently fielded emergency radios require several transmissions from the ground to provide a positive location, and require specially equipped aircraft to receive the signal. Personnel requiring assistance will often be deep in denied areas that are covered by effective radio intercept and air defense systems. Multiple transmissions from the

evaders and methodical searches by slow-moving aircraft are precluded because they lead to certain compromise, minimally resulting in capture of the evaders and possibly resulting in the ambush of a rescue force. The envisioned system must provide an immediate positive location and verification of the identity of the evader and provide for subsequent two-way communications with high-performance aircraft that can penetrate denied areas with relative safety. This would permit the launch of a rescue force with minimum delay and with greatly chances of success. Optimally, such a system would interface with satellites removing the requirement for an aircraft to be overhead to complete the link.

c. **Operational Concept.** The technology would be provided to all military aircrews and other military elements normally employed in denied or high-risk areas (e.g., special operation forces, reconnaissance units). Configured for satellite interface, this capability may be extended to civil aviation and marine activities, greatly enhancing non-combat search and rescue operations.

d. **Applicability.** The desired technology is applicable to all pilots in OOTW, war, or routine peacetime emergencies and to selected other military and civilian LEA personnel. The technology, once developed, will have broad applicability in the civilian aviation and maritime fields.

e. **Related Technology Areas.** Global Positioning System (GPS), data processing, secure communications, world-wide telecommunications nets, and micro-transmitters.

Virtual Reality Modeling and Simulations for Training, Planning, and Rehearsal

a. **Desired Capability.** A system that will project a variety of realistic OOTW operational environments. It must have broad applicability ranging from the projection of information in great detail for the micro-environments faced by individuals and small

units to the projection of the complexities of multiple concurrent events that demand the higher commander's attention.

b. Rationale. The ability to replicate the conditions of OOTW in field training environments is limited, expensive, and time-consuming. OOTW may occur with short notice, precluding any field training. A high-quality simulation system will permit the conduct of some level of training and orientation even when time is limited. It will also provide assistance in operational planning by permitting planners to "see" the operational area and to anticipate conditions and problems.

c. Operational Concept. The OOTW planning system would be available in all military units that have contingency missions. To facilitate mission preparation, equipment and a series of OOTW scenarios and regional map data would be established in all units down to at least battalion level. It would be used in training, area orientation, and as an adjunct to planning. It will require continuous update to reflect changes in map coverage, conditions, missions, and lessons learned.

d. Applicability. The desired technology is applicable to all military forces with potential OOTW employment. It would also be of great use to LEA for training and for the contingency planning of counter-drug and civil disorder operations.

e. Related Technology Areas. Computer graphics, modeling, and simulations.

PRIORITY III

Stand-Off Precision Breaching Weapons (Squad/Team)

a. **Desired Capability.** A person-portable weapons capability to penetrate walls or bunkers. Initially it should have sufficient accuracy to ensure hitting a target not larger than 1 meter square from a distance beyond effective small-arms range (500 meters). Subsequent development should permit successive increases in range: first to the limit of optically aided eyesight and eventually 5 to 10 kilometers using the assistance of implanted sensors and designators. (Weapon propellant would probably determine ultimate range.)

b. **Rationale.** Light forces, whether employed in war or OOTW, are at a marked disadvantage in penetrating buildings, bunkers, or fortified positions. Currently, weapons used for this purpose (usually available anti-armor weapons) have major limitations in explosive power, accuracy, and range. These limitations require that they be employed from short ranges and in multiples and even then produce only a minimal breaching effect. These characteristics limit effectiveness and increase the hazard to the soldiers employing them to attack fixed positions, particularly in urban areas.

c. **Operational Concept.** The weapon would be distributed as an ammunition item to light forces and would be a weapon option for special operations forces missions and conventional forces. The employment of the weapon would depend on the operational environment, but might include creating avenues of entry into buildings, rooms, and fortifications, as a fortification attack weapon ("bunker buster") for any type of ground units attacking fortifications or defended buildings. The weapon will also have utility as a stand-off weapon for use by special operations forces for road or waterway ambushes or the attack of critical targets such as missiles and their launch vehicles, ammunition storage sites, aircraft on the ground, electrical generation and transformer sites, and fuel

storage sites, and to complement the anti-armor weapons of Army and Marine light infantry forces. This advanced capability would be of crucial value in operations where these light forces are employed before the arrival of supporting heavy units (e.g., delaying forces, airheads, beachheads).

d. **Applicability.** The weapon would be employable in war and in a variety of OOTW by all military forces. Its accuracy and breaching capability would obviate the use of heavier weapons and explosives now used which have greater potential for collateral damage. Its applicability in law enforcement or other civil roles would be money dependent on its specific characteristics, i.e., a high explosive round would have very limited applicability because of its high probability of causing unacceptable destruction.

e. **Related Technology Areas.** Laser designation, rocketry, EMP, explosive's technology, and radar.

See-Through Capability for Buildings and Structures

a. **Desired Capability.** A means to determine the content and positioning of people, furniture, and equipment in buildings and structures without penetration or access to walls, roofs, etc. Minimally, this might be in the form of a "snapshot" or "X-ray." Optimally, this should provide for a real-time video of individuals and items inside a building.

b. **Rationale.** Determining the activities inside a building, room, or structure remains nearly impossible without entry or penetration and emplacement of a variety of sensors. A stand-off, see-through capability would be valuable to counter-terrorist, counter-drug and law enforcement forces conducting hostage rescue attempts or raids. The ability to distinguish between empty and occupied rooms and to determine occupant's activities and

major obstacles would represent a significant breakthrough in the ability to discriminate between potential targets and uninvolved persons.

c. **Operational Concept.** This capability would be used by military and counter-terrorist forces conducting hostage rescue attempts or raids. It would aid in positively identifying the target and location of people and things. It could also be used by LEA to screen suspected structures to verify the contents and activity going on inside. It would have utility in some disaster relief or rescue operations.

d. **Applicability.** The desired technology would be applicable to military forces involved in OOTW and law enforcement agencies in a variety of police raids and counter-drug activities. It could be used for disaster relief rescue operations as well as by intelligence agencies.

e. **Related Technology Areas.** X-ray and millimeter wavelength.

Universal, Long-life,/Light-Weight Power Source

a. **Desired Capability.** Individual power source that can provide power to various types of equipment (e.g., radios, position/navigation, mini-computer) within a wide range of terrain and climatic conditions.

b. **Rationale.** The electronics revolution has provided the individual soldier with a wide range of valuable electronic aids, each requiring a power source. Currently, these are powered by a variety of different and exorbitantly expensive batteries. Each battery (and its backup battery) adds to the weight the soldier must carry, thereby inducing fatigue and reducing effectiveness. Each battery has a different life expectancy, complicating resupply and increasing the risk to deep penetration forces and the logistics burden of all forces. For logistic efficiency, the number of different types of batteries must be reduced; for individual efficiency, the total weight of power sources must be

reduced. Optimally, a single, light-weight power source that is long-lived and readily rechargeable in the field is desired

c. **Operational Concept.** The individual will have a single universal power source to which electronic equipment is attached. The power source will be rechargeable while in use, using either environmental sources (e.g., solar) or human energy (e.g., body heat, movement). When available, the system could use external sources (commercial power, generators, or vehicles) for recharging.

d. **Applicability.** The technology could be used by dismounted troops in OOTW or war. It is also useful to LEA, particularly those operating in isolated areas (e.g., DEA agents, Border Patrol, etc.). Other potential civil users include forest rangers and fire fighters.

e. **Related Technology Areas.** Batteries, miniaturization, solar power (chemical photo voltaic), electrical generation, electrical insulation, and human engineering and medical.

Stand-off Neutralization of Weapons of Mass Destruction

a. **Desired Capability.** The ability to render WMD unusable or ineffective from a distance.

b. **Rationale.** Weapons of mass destruction are viewed as high-value strategic weapons by the nations that possess them. They are therefore closely protected by both information security and physical security systems. The latter usually include strong facilities and guard systems and reaction forces. (The need for technologies to locate these weapons is a major, but separate, problem addressed elsewhere.) When they have been located, these weapons must be attacked and secured with such speed, precision, and effectiveness that they can be disabled or destroyed without the enemy having the opportunity of recovering, moving, or employing them. Further, this must be done in a

manner that does not result in their detonation or the unacceptable release of their nuclear, biological, or chemical (NBC) contents.

c. **Operational Concept.** When the approximate location of the WMD is determined, it is attacked by the neutralizing weapon. Depending on the tactical environment (location, terrain, enemy air and ground defenses, etc.), this attack may be delivered by artillery, aircraft, UAV, missile, or small ground force units. Upon initiation, the attacking weapon neutralizes the WMD by disabling one or more of its vulnerable critical components. These components typically include the warhead's contents; the terminal fuzing; the propellant and propellant ignition systems; and the electrical, and control and communications systems.

d. **Applicability.** The weapons would be employed in OOTW and war by conventional air and ground forces and special operation forces. In addition, they could be used by national level-law enforcement organizations (e.g., FBI).

e. **Related Technology Areas.** Bacteriology, chemistry, rocketry, nuclear physics, and high-voltage electricity.

Strategic/ Discriminating Remote Sensors

a. **Desired Capability.** A remote sensor family that could be emplaced by a variety of means to include air, artillery, or ground emplacement. The family would include an assortment of interchangeable sensors that could be used in multiple configurations as desired. Sensors would include IR imagery, seismic, audio, electronic emission, compressed imaging, low-light television, and neutron and other nuclear detection systems. The sensors and their communications processors and transmitter should permit entry into communications systems through ground, aerial, or satellite links. The power supply must be small, but capable of sustaining the system for up to a year. Packaging

for low visibility for covert and clandestine use in a particularly wide range of different operational and climatic environments is desirable.

b. Rationale. There is a need in both OOTW and war to place sensors of varying types in permissive or denied areas to monitor movements, detect enemy vulnerabilities, and locate people and objects of vital interest.

c. Operational Concept. These sensors, once emplaced, will provide the commander a passive, low-risk method of collecting critical information without the adversary's knowledge. The operating philosophy is: "You can't defend against what you don't know is there." The deployed commander will have a choice of sensor configurations that best suit the requirements. The sensors would report data to the using command through existing or developing communications systems (e.g., the "CINC's Bubble") or other reliable means. The employing commander retains full control of the system.

d. Applicability. This capability would significantly enhance military capabilities and would have major applications in law enforcement, intelligence clandestine operations, and military covert operations in a full range of war and OOTW operations, with particular applicability in special operations.

e. Related Technology Areas. Multi-media sensors, long-life power sources, low-probability of intercept (LPI), spread spectrum (Morse-level) communications, interactive display consoles which can receive, record, and direct sensor activity, multi-spectral camouflage and other concealment technologies, and space-based or airborne communications relay capabilities

Biomedical-Treatment Capability

a. Desired capability. There is a need to:

- Remotely monitor the health of a soldier {Personnel Status Monitor (PSM)} and, when injured, to find the location and extent of injuries

(e.g., alive versus dead, serious or minor injury, shock, hypothermia)

- Provide remote treatment (including surgery) and to sustain life support during evacuation (Trauma Pod)
- Provide expert medical assistance through telemedicine as far rearward as CONUS
- Train surgeons in treatment of battlefield casualties through advanced simulation with virtual reality.

b. **Rationale.** On the battlefield, 90 percent of casualties occur in the far forward combat zone, where advanced medical capabilities are generally not available. The first and most critical hour is often consumed in locating, preparing and transporting the casualty. This situation is exacerbated in OOTW where advanced medical aid and logistic support are even more tenuous. Analogous situations may occur in law enforcement as well as in national disasters.

c. **Operational Concept.** The individual soldier or policeman will wear a Personal Status Monitor. When injured, his location and extent of injury will be immediately known. A medic can go directly to the injured individual, doing enroute triage based on reported vital signs. If too severely injured, a mobile surgical van (remote telepresence surgery) would allow a surgeon to provide life-saving surgery at the injured person's location by robotics. In addition, medical specialists from a CONUS or regional major medical center can provide medical assistance to the remote location. Using a virtual reality surgical simulator, surgeons can practice surgical procedures on simulated battlefield casualties.

d. **Applicability.** This technology is applicable to all forms of military engagement, civilian law enforcement, emergency medical care, and natural disaster crisis management.

e. **Related Technology Areas.** Remote sensing and monitoring, geolocation and positioning, robotics and telepresence, virtual reality and computer simulation, broad bandwidth communications, and high-performance computing and communications.

Strategic Airlift Capability

a. **Desired Capability.** A force projection capability that includes all-weather, low-cost strategic airlift platforms requiring minimum fixed- forward bases to rapidly transport multi-purpose forces from CONUS bases to areas of crisis or contingency.

b. **Rationale.** Developing U. S. strategy is based to a large extent on CONUS-based power projection. Inter-theater rapid deployment capability is the key element of this strategy, yet it is currently based on an aging airlift fleet. New low-cost strategic airlift capability is required to provide rapid, uninterrupted flow and sustained service support from peacetime U.S. bases or sanctuaries to the area of operations. Force projection was pivotal to the success of Operations Just Cause, Desert Shield/Desert Storm, Provide Comfort and Project Hope, as well as numerous other less well known contingencies. Deployments and support operations of a similar nature are key to OOTW and the success of U. S. force projection strategy.

c. **Operational Concept.** This aircraft will replace the aging fleet of USAF aircraft currently dedicated to inter theater or strategic airlift. The aircraft should be specifically designed for airlift from U. S. bases to fixed-station, secure airheads in or near the contingency areas. While the aircraft must be capable of sophisticated all-weather day or night operations into permissive airheads, it need not be designed to fulfill tactical airlift missions. The focus of the design of the platform must be high-speed, high-payload, long-range, quick-turnaround delivery, rather than tactical considerations such as the ability to operate from unimproved runways or to airdrop troops or equipment. The

aircraft should be adaptable to plug-in modules that will provide deploying forces C4I support enroute as required.

d. Applicability. The aircraft would be applicable to all military OOTW, to support UN or allied forces, and to most humanitarian assistance operations.

e. Related Technology Areas. Composite technology, short takeoff and landing (STOL), heavy-lift or specially designed helicopters, aerial refueling, sophisticated navigation and defensive electronic equipment, aerial port technology, radar, IR, night vision, satellite and other communications, navigation/position locating devices, aerial, sea- and land-based sensor technology, and materiel handling, loadmaster simulation model.

Floating Sea Base Capability

a. Desired Capability. An off-shore floating logistics base capable of receiving intra theater medium airlift and sealift The off-shore installation should consist of a floating modular system that can be tailored for specific operations to preclude or minimize U. S. presence on-shore. It must be able to sustain all-weather support for on-shore operations and receive replenishment by air or sea to maintain operations. It must be relocatable within 90 days.

b. Rationale. Developing U. S strategy is based on CONUS-based power projection. The sea-based platform will minimize U. S. presence on-shore and obviate the establishment of expensive fixed bases where no long-term presence is required. The sea base will provide for uninterrupted sustainment of on-shore activities, and provide for a secure haven remote from local harassing attacks. This will also reduce exposure of troops and equipment in theater.

c. Operational Concept. The off-shore logistics base will be positioned over-the-horizon (OTH) but within supporting range of ongoing long-term disaster relief, nation-

building or contingency operations. It will provide a secure, safe sustainment base reducing the requirements for static security forces and the size of the on-shore U. S. presence. This base may also serve as an off-shore training base for U. S. and indigenous personnel and, when coupled with medical ships or proper support packages, it may serve as an interim medical treatment facility for mass casualties.

d. Applicability. The capability would be applicable to all U. S. military forces or government and international organizations that may be involved in contingency operations in a denied area, disaster relief, or long-term humanitarian relief operations. The floating sea base would have significant commercial value.

e. Related Technology Areas. STOL, heavy lift rotary or fixed wing aircraft, Sea Delivery, Vehicle, deep submersible recovery vehicles (DSRVs), amphibious and maritime technologies, including offshore habitats or hydrospace platforms, and materiel handling, loadmaster simulation model.

APPENDIX A

TERMS OF REFERENCE FOR

ARPA MILITARY OPERATIONS OTHER THAN WAR

SENIOR WORKING GROUP

BACKGROUND

Based on discussions with a number of DoD and Service organizations, and recent events in Somalia, ARPA has identified both a need and an opportunity to make a significant contribution to U. S. military capability through the development of advanced technologies to enhance the effectiveness and survivability of U. S. forces engaged in OOTW. Although the focus of this effort is long-term, development of key near- and mid-term enabling technologies are also of interest for application to real time problems in such areas as Somalia.

CONCLUSION

The objective of this Steering Committee is to assist ARPA in the development of a vision and implement plan for this effort. In this regard, the Committee will:

- Review potential missions
- Identify key problem areas
- Define technology options
- Recommend a strategy.

At the conclusion of its efforts, the Committee will provide ARPA with a report that includes:

- A vision statement for the ARPA initiative to include a definition of OOTW
- Rationale supporting this initiative, assessing requirements and technology
- Program recommendations with rationale, addressing new systems technologies.

ANTICIPATED LEVEL OF EFFORT AND SCHEDULE

This will be an intense 7-week effort beginning on October 14, 1993 and ending November 23, 1993. Administrative and technical support for this Committee will be provided by Systems Planning Corporation.

APPENDIX B

BRIEFINGS

Subject	Office	Presenter
Advanced Land Systems Steering Committee Outbrief	ARPA	GEN Glenn Otis
GPS Receiver on Multichip Form	ARPA	Maj. Beth Kasper
Micro Tracker Receivers	ARPA	Maj. Beth Kasper
Advanced Biomedical Technology Program	ARPA	COL Richard Satava
Voice Recognition/Understanding/Translation	ARPA	Dr. George Doddington
BCI Process	ARPA	Mr. Tom Hafer
Directed Energy Weapons	ARPA	Dr. L.N. Durvasula
ARPA/ASTO	ARPA	Dr. Bill Scheuren
Digitizing the Battlefield	ARPA/ CECOM	Mr. Tom Hafer/ Mr. Rob Ruth
Warbreaker/Weapons of Mass Destruction	ARPA	Mr. Chuck Heber
Quick Reaction Effort for U.S. Forces in Somalia	ARPA	LTC Robert Kocher
Counter-Proliferation	ARPA	Dr. Judith Daly
Counter Drug Program	ARPA	Mr. John Pennella
UAV Technology Demonstrations Program	PEO Cruise Missile/UAV	
Joint Unmanned Aerial Vehicle Program Hand-Launched Unmanned Aerial Vehicle		COL Brad Brown LTC Tim Lindsey
Smart Bullet Briefing	Martin Marietta	Mr. W.P. Bonnell
Military Operations Other Than War	JCS J-7	COL Tackaberry
Joint Doctrine Development	JCS J-7	COL Tackaberry
Non-Lethal Technologies	TECHMATICS	Mr. Paul Evancoe
Low Energy Lasers		

High Power Microwave
Superconductor Technology
Isotropic Radiators
Non-Nuclear Electromagnetic Pulse
Infrasound
Visual Stimulation and Illusion
Liquid Metal Embrittlement
Supercaustics
Superoxidants
Anti-traction
Anti-lubricants
Polymer Agents
Combustion Alteration
Calmative Agents

Army Combat Identification Program	U.S. Army CECOM	COL Thomas Rosner
Technology Areas		Naval Ordnance Center/Explosive Ordnance Division

- Sensors
  RF Line-of-Sight Navigation
  SONAR
  Magnometers
- Directed Energy
  Laser Marker
  UIS
  Portable HPM
- Low Signature
  Non-Magnetic Electronics
  Non-Magnetic Power
  Closed Circuit + Valving
- Robotics
  U/W RDU
  Surface Remotely Controlled Vehicle
- Computers
  EOO Publication Automation
  Mission Planning
  Data Fusion
  Integrated Research Systems
- Explosives
  Low Velocity Shaped Charges
  Explosives Detection

Close Combat Fire Suppression	LLNL	Special Studies Program
Night Vision & Electronics	CECOM RDEC	Mr. Ferdinand C. Petito

Operations Other Than War, Peace Enforcement	USAIS Close Combat Battle Laboratory	LTC Mike Smith
Electromagnetic Weapons	Idaho National Lab	Mr. Harry Feuerstein/ Dr. Clifton Stine
Active Camouflage	David Sarnoff Laboratory	Dr. Tom Lippert
Policy	Director, Policy & Plans, OASD, SO/LIC	Dr. Chris Lamb
Future Plans for Forces and Material	Director, Acquisition OASD, SO/LIC	Mr. Bob Doheny
DIA Briefing		Mr. John Sullivan
CIA Briefing	Office of R&D	Mr. Dennis Fitzgerald

APPENDIX C

GLOSSARY

AFSOF	Air Force Special Operations Forces
ARPA	Advanced Research Projects Agency
BAA	Broad Agency Announcement
C^2	Command and Control
C^3	Command, Control and Communications
C^4I	Command, Control, Communications, Computers and Intelligence
CECOM	Communications Electronics Command, U.S. Army
CIA	Central Intelligence Agency
CINC	Commander-in-Chief
CONUS	Continental United States
CSAR	Combat Search and Rescue
DEA	Drug Enforcement Administration
DIA	Defense Intelligence Agency
DLEA	Drug Law Enforcement Agencies
DoD	Department of Defense
DSRV	Deep Submersible Recovery Vehicle
EMP	Electro-magnetic Pulse
FAA	Federal Aviation Administration
FBI	Federal Bureau of Investigation
GCCS	Global Command and Control Systems
GPS	Global Positioning Systems
HPCC	High Performance Computing and Communications
HUMINT	Human Resources Intelligence
IR	Infrared
JCS	Joint Chiefs of Staff
LDC	Less Developed Country(s)
LEA	Law Enforcement Agencies
LLNL	Lawrence Livermore National Laboratory
LPI	Low Probability of Intercept
NBC	Nuclear, Biological, Chemical
NAVSPECWAR	Naval Special Warfare (U.S .Navy)
NSA	National Security Agency
NV	Night Vision
OTH	Over-the-Horizon

OOTW	Operations Other Than War
OASD SO/LIC	Office of the Assistant Secretary of Defense (Special Operations/Low-Intensity Conflict)
POW	Prisoner of War
POSNAV	Position/Navigation
PSM	Personal Status Monitor
PSYOP	Psychological Operations
R&D	Research and Development
RF	Radio Frequency
SOF	Special Operations Forces
STOL	Short Take Off and Landing
SWG	Senior Working Group
TV	Television
UAV	Unmanned Aerial Vehicle
U.S.	United States
USA	United States Army
USAF	United States Air Force
USAIS	United States Army Infantry School
USMC	United States Marine Corps
USN	United States Navy
VIP	Very Important Person
WMD	Weapons of Mass Destruction

ANNEX D

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